

REFERENCES

- Arbib, M.A. [1966]. "A simple self-reproducing universal automaton." *Information and Control*. Vol. 9, pp. 177-189.
- Arbib, M.A. [1967]. "Automata theory and development: Part I." *Theoretical Biology*. Vol. 14, pp. 131-156.
- Arbib, M.A. [1987]. *Brains, Machines, and Mathematics*. (2nd Edition). Springer-Verlag.
- Aronson, J.L., R. Harré, and E.C. Way [1995]. *Realism Rescued: How Scientific Progress is Possible*. Open Court.
- Ashby, W.R. [1962]. "Principles of the self-organizing system." In: *Principles of Self-Organization*. H. von Foerster and G.W. Zopf (eds.). Pergamon Press. Reprinted in Klir [1991], pp. 521-536.
- Atanassov, K. [1986]. "Intuitionistic fuzzy sets." *Fuzzy Sets and Systems*. Vol. 64, pp. 159-174.
- Atanassov, K. [1994]. "Operators over interval valued intuitionistic fuzzy sets." *Fuzzy Sets and Systems*. Vol. 64, pp. 159-174.
- Atanassov, K. and G. Gargov [1994]. "Interval valued intuitionistic fuzzy sets." *Fuzzy Sets and Systems*. Vol. 31, pp. 343-349.
- Barsalou, L. [1987]. "The instability of graded structure: implications for the nature of concepts." In: *Concepts and Conceptual Development: Ecological and Intellectual Factors in Categorization*. U. Neisser (ed.). Cambridge University Press.
- Benne, R. (Ed.) [1993]. *RNA Editing: The Alteration of Protein Coding Sequences of RNA*. Ellis Horwood Publishers.
- Benne, R., J. van den Burg, J.P.J. Brakenhoff, J.H. van Boom, and M.C. Tromp [1986]. "Major transcript of the frameshifted coxII gene from trypanosome mitochondria contains four nucleotides that are not encoded in the DNA." *Cell*. Vol. 46, pp. 819-826.
- Bickerton, D. [1990]. *Language and Species*. University of Chicago Press.
- Bickhard, M.H. and D.M. Richie [1983] *On the Nature of Representation*. Praeger.
- Blum, B., N. Bakalara, and L. Simpson [1990]. "A model of RNA editing in kinetoplast mitochondria: "guide" RNA molecules transcribed from minicircle DNA provide the edited information." *Cell*. Vol. 60, pp. 189-198.
- Boulding, K. E. [1956]. "General Systems Theory – the skeleton of science." *Management Science*. Vol. 2, pp. 197-208. Reprinted in Klir [1991] pp. 239-248.
- Brooks, R.A. [1991]. "Intelligence without reason." In: *Proceedings of the 12th International Conference on Artificial Intelligence, San Mateo 1992*. Morgan Kaufmann.
- Buss, L. [1987]. *Evolution of Individuality*. Princeton University Press.
- Campbell, D.T. [1974]. "Evolutionary Epistemology." In: *The Philosophy of Karl Popper*. P.A. Schilpp (ed.). Open Court Publishers, pp. 413-463.
- Cariani, Peter [1989]. *On The Design of Devores With Emergent Semantic Functions*. PhD Dissertation. State University of New York at Binghamton.
- Cariani, Peter [1992]. "Emergence and Artificial Life." In: *Artificial Life II*. C. Langton, C. Taylor, J.D. Farmer, and S. Rasmussen (eds.). SFI Series in the Sciences of Complexity. Addison-Wesley, pp. 775-797.

- Cariani, Peter [1995]. "Towards an evolutionary semiotics: the role of symbols in organisms and adaptive devices." In: *International Seminar on Evolving Systems, Vienna, 1995*. G. Van de Vijver and S. Salthe (eds.). Kluwer (In Press).
- Cassirer, E. [1946]. *Language and Myth*. Dover.
- Chomsky, N. [1965]. *Aspects of the Theory of Syntax*. MIT Press.
- Churchland, P. and T. Sejnowski [1992]. *The Computational Brain*. MIT Press.
- Clark, Andy [1993]. *Associative Engines: Connectionism, Concepts, and Representational Change*. MIT Press.
- Clark, Andy [1996]. "Happy couplings: emergence and explanatory interlock." In: *The Philosophy of Artificial Life*. M. Boden (ed.). Oxford University Press, pp. 262-281.
- Conrad, Michael [1983]. *Adaptability*. Plenum Press.
- Conrad, Michael [1990]. "The geometry of evolutions." *BioSystems*. Vol. 24, pp. 61-81.
- Crutchfield, J.P. and M. Mitchell [1995]. "The evolution of emergent computation." *Proc. National Academy of Sciences, USA, Computer Sciences*. Vol. 92, pp. 10742-10746.
- Dawkins, R. [1976]. *The Selfish Gene*. Oxford University Press.
- Dawkins, R. [1987]. *The Blind Watchmaker: Why the Evidence of Evolution Reveals a Universe Without Design*. Norton.
- de Cooman, G., D. Ruan, and E. Kerre (eds.) [1995]. *Foundations and Applications of Possibility Theory*. World Scientific.
- Dellaert, Frank and R.D. Beer [1994]. "Toward an evolvable model of development for autonomous agent synthesis." *Artificial Life IV*. R. Brooks and P. Maes (eds.). MIT Press. pp. 246-257.
- Dempster, A. [1967]. "Upper and lower probabilities induced by multivalued mappings." *Annals of Mathematical Statistics*. Vol. 38, pp. 325-339.
- Dennet, D.C. [1995]. *Darwin's Dangerous Idea: Evolution and The Meanings of Life*. Simon and Schuster.
- Derrida, J. [1988]. *Limited Inc.* Northwestern University Press.
- Dinsmore, J. (ed.) [1992]. *The Symbolic and Connectionist Paradigms: Closing the Gap*. Lawrence Erlbaum.
- Dubois, D. and H. Prade [1985]. "A note on measures of specificity for fuzzy sets." *International Journal of General Systems*. Vol. 10, pp. 279-283.
- Dubois, D. and H. Prade [1986]. "A set-theoretic view of belief functions: logical operations and approximations by fuzzy sets." *Int. Journal of General Systems*. Vol. 12, pp. 193-226.
- Dubois, D. and H. Prade [1987]. "Properties of measures of information in evidence and possibility theories." *Fuzzy Sets and Systems*. Vol. 24, pp. 161-182.
- Eigen, M. [1992]. *Steps Towards Life: A Perspective on Evolution*. Oxford University Press.
- Eldridge, N. [1995]. "A battle of words." In: *The Third Culture: Beyond The Scientific Revolution*. J. Brockman. Simon and Schuster, pp. 119-128.
- Etxeberria, Arantza [1995]. "Embodiment of Natural and Artificial Agents." In: *International Seminar on Evolving Systems, Vienna 1995*. G. van de Vijver and S. Salthe. Kluwer.
- Fillmore, C. [1982]. "Frame semantics." In: *Linguistics in the Morning Calm*. Linguistics Society of Korea. Hanshin, pp. 111-138.
- Fodor, J. [1981]. *Representations: Philosophical Essays on the Foundations of Cognitive Science*. MIT Press.
- Forrest, S. (ed.) [1991]. *Emergent Computation*. MIT Press.
- Galvin, F. and S.D. Shore [1991]. "Distance functions and topologies." *The American Mathematical Monthly*. Vol. 98, No. 7, pp. 620-623.
- Glanville, R. [1988]. *Objekte*. Merve Verlag.
- Glanville, R. [1994]. "as if." In: *Cybernetics and Systems 94*. R. Trapp (ed.). Vol. 1, pp. 613-620.

- Goldberg, D.E. [1989]. *Genetic Algorithms in Search, Optimization, and Machine Learning*. Addison-Wesley.
- Goodwin, B. [1994]. *How the Leopard Changed its Spots: The Evolution of Complexity*. Charles Scribner's Sons.
- Gorzałczany, M.B. [1987]. "A method of inference in approximate reasoning based on interval-valued fuzzy sets." *Fuzzy Sets and Systems*. Vol. 21, pp. 1-17.
- Gould, S.J. [1989]. *Wonderful Life*. Norton.
- Gould, S.J. [1995]. "The pattern of life's history." In: *The Third Culture: Beyond the Industrial Revolution*. J. Brockman (ed.). Simon and Schuster, pp. 51-73.
- Gruau, F. [1992]. "genetic synthesis of boolean neural networks with a cell rewriting developmental process." In: *Proceedings of the International Workshop on Combinations of Genetic Algorithms and Neural Networks*. L.D. Whitley and J.D. Schaffer. IEEE Press, pp. 55-74.
- Haken, H. [1977]. *Synergetics*. Springer-Verlag.
- Hamming, R.W. [1980]. *Coding and Information Theory*. Prentice-Hall.
- Hampton, J. [1992]. "Prototype models of concept representation." In: *Categories and Concepts: Theoretical Views and Inductive Data Analysis*. I. Van Mechelen, J. Hampton, R. Michalski, and P. Theuns. Academic Press.
- Harmanec, D. and G. Klir [1994]. "Measuring total uncertainty in Dempster-Shafer theory: a novel approach." *Int. J. of General Systems*. Vol. 22, pp. 405-419.
- Hartley, R. [1928]. "Transmission of informations." In: *The Bell System Technical Journal*. Vol. 7, pp. 31-46.
- Henry, C. and L.M. Rocha [1996]. "Language theory: consensual selection of dynamics." In: *Cybernetics and Systems: An International Journal*. . Vol. 27, pp 541-553.
- Henry, Charles [1995]. "Universal Grammar." *Communication and Cognition - Artificial Intelligence*. Vol. 12, Nos. 1-2, pp. 45-62.
- Heylighen, F. and C. Joslyn [1992]. "Physical constructivism." *Principia Cybernetica Web*. WWW document: <http://pespmc1.vub.ac.be/physcons.html>.
- Higashi, M. and G. Klir [1983]. "Measures of uncertainty and information based on possibility distributions." *Int. J. of General Systems*. Vol. 9, pp. 43-58.
- Hirota, K. [1981]. "Concepts of probabilistic sets." *Fuzzy Sets and Systems*. Vol. 5, pp. 31-46.
- Holland, J.H. [1975]. *Adaptation in Natural and Artificial Systems*. University of Michigan Press.
- Holyoak, K.J. and P. Thagard [1995]. *Mental Leaps: Analogy in Creative Thought*. MIT Press.
- Hooker, C.A. [1995]. *Reason, Regulation and Realism: Towards a Regulatory Systems Theory of Reason and Evolutionary Epistemology*. State University of New York Press.
- Hordijk, W., J.P. Crutchfield, and M. Mitchell [1996]. "Embedded-particle computation in evolved cellular automata." In: *Proceedings of Physics and Computation 96*. In Press. Available as a Santa Fe Institute preprint (96-09-073).
- Husbands, P., I. Harvey, D. Cliff, and G. Miller [1994]. "The use of genetic algorithms for the development of sensorimotor control systems." In: *Proc. of the International Workshop from Perception to Action*. P. Gaussier and J. Nicoud (eds.). IEEE Press, pp. 110-121.
- Jacobson, P. [1982]. *The Nature of Syntactic Representation*. Kluwer.
- James, W. [1892]. *Psychology: The Briefer Course*. University of Notre-Dame Press, 1985..
- Kampis, George [1991]. *Self-Modifying Systems in Biology and Cognitive Science*. Pergamon Press.
- Kauffman, S. [1993]. *The Origins of Order: Self-Organization and Selection in Evolution*. Oxford university Press.
- Kauffman, S. [1995]. "Order for free." In: *The Third Culture: Beyond the Scientific Revolution*. J. Brockman (ed.). Simon and Schuster, pp. 333-343.

- Kitano, H. [1994]. "Evolution of metabolism for morphogenesis." In: *Artificial Life IV*. R.A. Brooks and P. Maes (eds.). MIT Press. pp 49-58.
- Kitano, H. [1995]. "Cell differentiation and neurogenesis in evolutionary large scale chaos." In: *Advances in Artificial Life*. F. Moran et al (Eds.). Springer-Verlag. pp. 341-352..
- Klir, G.J. and T. Folger [1988]. *Fuzzy Sets, Uncertainty, and Information*. Prentice Hall.
- Klir, G.J. and B. Parviz [1992]. "A note on the measure of discord." In: *Proceedings of the Eighth Conference on Artificial Intelligence*. D. Dubois (ed.). Morgan Kaufmann, pp. 138-141.
- Klir, G.J. and A. Ramer [1990]. "Uncertainty in the Demster-Shafer theory: a critical re-examination." *Int. J. of General Systems*. Vol. 18, pp. 155-166.
- Klir, G.J. and M.J. Wierman [1997]. *Uncertainty-Based Information: Elements of Generalized Information Theory*. Lecture Notes in Fuzzy Mathematics and Computer Science. Creighton University, Omaha, Nebraska.
- Klir, G.J. and B. Yuan [1993]. "On measures of conflict among set-valued statements." In: *Proceedings of the 1993 World Congress on Neural Networks; July 11-15, 1993, Portland, Oregon*. pp. 627-630.
- Klir, G.J. and B. Yuan [1995]. *Fuzzy Sets and Fuzzy Logic: Theory and Applications*. Prentice Hall.
- Klir, George, J. [1991]. *Facets of Systems Science*. Plenum Press.
- Klir, George, J. [1993]. "Developments in uncertainty-based information." In: *Advances in Computers*. M. Yovits (Ed.). Vol. 36, pp. 255-332.
- Kramosil, I. [1995]. "Believeability and plausibility functions over infinite sets." *Int. J. of General Systems*. Vol. 23, pp. 173-198.
- Lakoff, G. [1987]. *Women, Fire, and Dangerous Things: What Categories Reveal about the Mind*. University of Chicago Press.
- Langton, C.G. [1989]. "Artificial life." In: *Artificial Life*. C. Langton (ed.). Addison-Wesley.
- Langton, C.G. [1990]. "Computation at the edge of chaos: phase transitions and emergent computation." *Physica D*. Vol. 42, pp. 12-37.
- Laszlo, E. [1987]. *Evolution: The Grand Synthesis*. New Science Library.
- Leduc, S. [1911]. *The Mechanism of Life*. Renman, London..
- Lee, K.M., J. Favrel, H. Lee-Kwang, and C.B. Kim [1996]. "Fuzzy convolution as a nonlinear digital filter." In: *Proceedings of the 1996 NAFIPS Conference, Berkley 1996*. M.H. Smith, M.A. Lee, J. Keller, and J. Yen (eds). IEEE Press, pp. 577-580.
- Levins, R. [1968]. *Evolution in Changing Environments: Some Theoretical Explorations*. Princeton University Press.
- Lomeli, H. et al [1994]. "Control of kinetic properties of AMPA receptor channels by nuclear RNA editing." *Science*. Vol. 266, pp 1709-1713..
- Lorenz, K. [1965]. *Evolution and Modification of Behavior*. Chicago University Press.
- Lorenz, K. [1971]. "Knowledge, beliefs and freedom." In: *Hierarchically Organized Systems in Theory and Practice*. P. Weiss (ed.). Hafner.
- Lorenz, K. [1981]. *The Foundations of Ethoogy*. Springer-Verlag.
- Mataric, M.J. [1995]. "Evaluation of learning performance of situated embodied agents." In: *Advances in Artificial Life*. F. Moran, A. Moreno, J.J. Merelo, and P. Chacon (eds.). Springer-Verlag, pp. 579-589.
- Maturana, H. [1979]. "Biology of language: the epistemology of reality." *Psychology and Biology of Language and Thought: Essays in honor of Eric Lenneberg*. Academic Press, pp. 27-63.
- Maturana, H. and F. Varela [1987]. *The Tree of Knowledge: The Biological Roots of Human Understanding*. New Science Library.
- Maynard Smith, J. [1986]. *The Problems of Biology*. Oxford University Press.
- McCulloch, W.S. and W. Pitts [1943]. "A logical calculus of the ideas immanent in nervous activity." *Bulletin of Mathematical Biophysics*. vOL. 5, PP. 115-133.

- Medin, D.L. and M.M. Schafer [1978]. "A context theory of classification learning." In: *Psychological Review*. . Vol. 35, pp. 207-238.
- Medina-Martins, P. and L. Rocha [1992]. "The in and the out: an evolutionary approach." In: *Cybernetics and Systems* 92. R. Trappi (Ed.). World Scientific Press, pp. 681-689.
- Medina-Martins, P., L. Rocha, et al [1993]. *CYBORGS: A Fuzzy Conversational System*. Final report for the NATO International Program on Learning Systems.
- Medina-Martins, P., L. Rocha, et al [1994]. "Metalogues: an essay on computers' psychology – from childhood to adulthood." In: *Cybernetics and Systems* 94. R. Trappi (Ed.). World Scientific Press, pp. 565-572.
- Medina-Martins, Pedro [1995]. "Metalogues: an abridge of a genetic psychology of non-natural systems." *Communication and Cognition - Artificial Intelligence*. Vol. 12, Nos. 1-2, pp. 111-156.
- Minch, Eric [1995]. "The beginning of the End: on the origin of final cause." In: *International Seminar on Evolving Systems, Vienna March 1995*. G. van de Vijver and S. Salthe (eds.). Kluwer (In Press).
- Minsky, M. [1975]. "A framework for representing knowledge." In: *The Psychology of Computer Vision*. P. Winston (ed.). McGraw-Hill.
- Mitchell, Melanie [1996a]. *An Introduction to Genetic Algorithms*. MIT Press.
- Mitchell, Melanie [1996b]. "Computation in cellular automata: a selected review." In: *Nonstandard Computation*. H.G. Schuster and T. Gramms (eds.). VCH Verlagsgesellschaft (In Press). Available as Santa Fe Institute Preprint (96-09-074).
- Montana, D.J. and L.D. Davis [1989]. "Training feedforward networks using genetic algorithms." In: *Proceedings of the International Joint Conference on Artificial Intelligence*. . Morgan Kaufmann.
- Moreno, A., A. Etxeberria, and J. Umerez [1994]. "Universality without matter?." In: *Artificial Life IV*. R. Brooks and P. Maes (eds.). MIT Press, pp. 406-410.
- Morris, C.W. [1946]. *Signs, Language, and Behavior*. G. Braziller Publishers..
- Nakamura, K. and S. Iwai [1982]. "A representation of analogical inference by fuzzy sets and its application to information retrieval systems." In: *Fuzzy Information and Decision Processes*. Gupta and Sanchez (Eds.). North-Holland, pp. 373-386.
- Nicolis, G. and I. Prigogine [1977]. *Self-Organization in Nonequilibrium Systems: From Dissipative Structures to Order through Fluctuations*. Wiley-Interscience.
- Osherson, D. and E. Smith [1981]. "On the adequacy of prototype theory as a theory of concepts." *Cognition*. Vol. 9, pp. 35-58.
- Packard, N. [1988]. "Adaptation to the edge of chaos." In: *Complexity in Biologic Modelling*. S. Kelso and M. Shlesinger (eds.). 21
- Papert, S. [1991]. "Situating construction." In: *Constructivism*. I. Harel and S. Papert (eds.). Ablex Publishing.
- Pask, Gordon [1975]. *Conversation, Cognition, and Learning: A Cybernetic Theory and Methodology*. Elsevier.
- Pask, Gordon [1976]. *Conversation Theory: Applications in Education and Epistemology*. Elsevier.
- Pask, Gordon [1992]. "Different kinds of cybernetics." In: *New Perspectives on Cybernetics*. G. van de Vijver (ed.). Kluwer, pp.11-31.
- Pattee, Howard H. (Ed.) [1973]. *Hierarchy Theory: The Challenge of Complex Systems*. George Braziller, New York.
- Pattee, Howard H. [1978]. "The complementary principle in biological and social structures." *Journal of Social and Biological Structures*. Vol. 1, pp. 191-200.
- Pattee, Howard H. [1982]. "Cell psychology: an evolutionary approach to the symbol-matter problem." *Cognition and Brain Theory*. Vol. 5, no. 4, pp. 191-200.
- Pattee, Howard H. [1989]. "Simulations, realizations, and theories of life." In: *Artificial Life*. C. Langton (ed.). SFI Series in the Sciences of Complexity. Addison-Wesley, pp. 63-77.

- Pattee, Howard H. [1995a]. "Evolving self-reference: matter, symbols, and semantic closure." *Communication and Cognition - Artificial Intelligence*. Vol. 12, nos. 1-2 (Rocha[1995a]), pp. 9-27.
- Pattee, Howard H. [1995b]. "Artificial life needs a real epistemology." In: *Advances in Artificial Life*. F. Moran, et al. Springer-Verlag. pp 23-38.
- Piaget, J. [1971]. *The Construction of Reality in the Child*. Ballantine Books.
- Pinker, S. [1993]. *The Language Instinct*. Morrow.
- Pollack, R. [1994]. *Signs of Life: The Language and Meanings of DNA*. Houghton Mifflin.
- Poundstone, W. [1987]. *The Recursive Universe*. Oxford University Press.
- Prem, Erich [1995]. "Grounding and the entailment structure in robots and Artificial Life." In: *Advances in Artificial Life*. F. Moran, A. Moreno, J.J. Merelo, and P. Chacon (eds.). Springer-Verlag, pp. 39-52.
- Prigogine, I. [1985]. "New perspectives on complexity." In: *The Science and Praxis of Complexity*. United Nations Library. Reprinted in Klir [1991].
- Ramer, A. [1987]. "Uniqueness of information measure in the theory of evidence." *Fuzzy Sets and Systems*. Vol. 24, pp. 183-196.
- Ramer, R. [1990]. "Concepts of fuzzy information on continuous domains." *Int. J. of General Systems*. Vol. 17, pp. 241-248.
- Ramsey, W.M., S.P. Stich, and D.E. Rumelhart (eds.) [1991]. *Philosophy and Connectionist Theory*. Lawrence Erlbaum.
- Random House, [1994]. *Webster's Electronic Dictionary and Thesaurus*. WordPerfect Corporation.
- Rennie, J. [1993]. "DNA's new twists." *Scientific American*. March 1993.
- Resconi, G., G. Klir, U. St.Clair, and D. Harmanec [1993]. "On the Integration of Uncertainty Theories." *International Journal Of Uncertainty, Fuzziness and Knowledge Based Systems*. Vol. 1, No. 1, pp. 1-18.
- Riedl, R [1977]. "A systems-analytical approach to macro-evolutionary phenomena." *Quarterly Review of Biology*. Vol. 52, pp. 351-370.
- Riedl, R. [1984]. *Biology of Knowledge*. Wiley.
- Rocha, Luis, M. [1991]. "Fuzzification of conversation theory." In: . F. Heylighen (Ed.). Paper delivered at the Principia Cybernetica Workshop, Free University of Brussels.
- Rocha, Luis, M. [1994a]. "Cognitive categorization revisited: extending interval valued fuzzy sets as simulation tools concept combination." *Proceedings of the 1994 International Conference of NAFIPS/IFIS/NASA*. IEEE Press, pp. 400-404.
- Rocha, Luis M. [1994b]. "Von Foerster's cognitive tiles: semantically closed building blocks for AI and ALife." In: *Cybernetics and Systems' 94*. R. Trappi (Ed.). World Scientific Press. pp. 621-628.
- Rocha, Luis M. (Ed.) [1995a]. *special issue in Self-Reference in Biological and Cognitive Systems of Communication and Cognition - Artificial Intelligence*. Vol. 12 nos. 1-2.
- Rocha, Luis M. [1995b]. "Artificial semantically closed objects." *Communication and Cognition - Artificial Intelligence*. Vol. 12, nos 1-2, (Rocha[1995a]) pp. 368-382.
- Rocha, Luis M. [1995c]. "Contextual genetic algorithms: evolving developmental rules." In: *Advances in Artificial Life*. J. Moran, A. Moreno, J.J. Merelo, and P. Chacon (Eds.). Springer -Verlag, pp. 368-382.
- Rocha, Luis M. [1995d]. "Interval based evidence sets." *Proc. of ISUMA-NAFIPS'95*. IEEE Press, pp. 624-629.
- Rocha, Luis [1995e]. *Evolutionary Systems and Artificial Life - Lecture Notes*. WWW Document. <http://ssie.binghamton.edu/~rocha/alife.html>.
- Rocha, Luis M. [1995f]. "Selected self-organization: from eigenbehavior to descriptions." In: *Proceedings of the International Seminar on Evolving Systems, Vienna 1995*. S. Salthe and G. Van de Vijver. Kluwer. (in press).

- Rocha, Luis M. [1996a]. "Eigenbehavior and symbols." *Systems Research*. Vol. 13, No. 3, pp. 371-384.
- Rocha, Luis M. [1996b]. "Relative uncertainty: measuring uncertainty in discrete and nondiscrete domains." In: *Proceedings of the NAFIPS'96*. M. Smith et al (Eds.). IEEE Press. pp. 551-555.
- Rocha, Luis M. [1997a]. "Relative uncertainty and evidence sets: a constructivist framework." *International Journal of General Systems*. Vol. 25. (In Press).
- Rocha, Luis M. [1997b]. "Evidence Sets: Contextual Categories." In: *Semiotics and Control of Complex Systems*. M. Coombs and J. Casti (Eds.). Santa Fe Institute Series in the Sciences of Complexity. Addison-Wesley. (In Press).
- Rocha, Luis M. [1997c]. "Interval based evidence sets: modeling subjective categories." *International Journal of General Systems*. In Press.
- Rocha, Luis M. [1997d]. "Fuzzy Development Programs: Emergent Classification and Embodied Genetic Algorithms." *Evolutionary Computation*. (Submitted).
- Rocha, Luis M., V. Kreinovich, and K. B. Kearfott [1996]. "Computing uncertainty in interval based sets." In: *Applications of Interval Computations*. V. Kreinovich and K.B. Kearfott (Eds.). Kluwer Academic Publishers, pp. 337-380.
- Rosch, E. [1975]. "Cognitive representations of semantic categories." *J. of Experimental Psychology*. Vol. 104, pp. 27-48.
- Rosch, E. [1978]. "Principles of categorization." In: *Cognition and Categorization*. E. Rosch and B. Lloyd (Eds.). Hillsdale, pp. 27-48.
- Rosen, Robert [1985]. *Anticipatory Systems*. Pergamon Press.
- Rosen, Robert [1991]. *Life Itself*. Columbia University Press.
- Rosen, Robert [1993]. "Bionics revisited." In: *The Machine as a Metaphor and Tool*. H. Haken, A. Karlqvist, and U. Svedin (eds.). Springer-Verlag, pp. 87-100.
- Rosen, Robert [1995]. "The mind-brain problem and the physics of reductionism." *Communication and Cognition - Artificial Intelligence*. Vol. 12, nos. 1-2 (Rocha[1995a]) pp. 29-43.
- Rumelhart, D. [1975]. "Notes on a schema for stories." In: *Representation and Understanding: Studies in Cognitive Science*. D.Bobrow and A. Collins (eds.). Academic Press, pp. 211-236.
- Salthe, Stanley N. [1985]. *Evolving Hierarchical Systems*. Columbia University Press.
- Salthe, Stanley N. [1991]. "Varieties of Emergence." *World Futures*. Vol. 32, pp. 69-83.
- Salthe, Stanley N. [1993]. *Development and Evolution: Complexity and Changes in Biology*. MIT Press.
- Salthe, Stanley N. [1995]. "A Peircean semiotic interpretation of development." *Ludus Vitalis*. Vol. 3, No. 4, pp. 15-228.
- Schum, D.A. [1994]. *Evidential Foundations of Probabilistic Reasoning*. John Wiley and Sons.
- Seiwart, S.D. and K. Stuart [1994]. "RNA Editing: transfer of genetic information from gRNA to precursor mRNA in Vitro." *Science*. Vol. 226, pp. 114-116.
- Shafer, G. [1976]. *A Mathematical Theory of Evidence*. Princeton University Press.
- Shafer, G. and J. Pearl (Eds.) [1990]. *Readings in Uncertain Reasoning*. Morgan Kauffman.
- Simpson, L. and D. Maslov [1994]. "RNA editing and the evolution of parasites." *Science*. Vol. 264, pp. 1870-1871.
- Smith, E.E. and D.L. Medin [1981]. *Categories and Concepts*. Harvard University Press.
- Smith, E. and D. Osherson [1984]. "Conceptual combination with prototype concepts." *Cognitive Science*. Vol. 8, pp. 337-361.
- Stuart, K. [1993]. "RNA editing in mitochondria of african trypanosomes." In: *RNA Editing : The Alteration of Protein Coding Sequences of RNA*. R. Benne (Ed.). Ellis Horwood. pp. 26-52.
- Sturn, N.R. and L. Simpson [1990]. "Kinetoplast DNA minicircles encode guide RNA's for editing of cytochrome oxidase subunit III mRNA." *Cell*. Vol. 61, pp.879-884.
- Thom, R. [1976]. *Structural Stability and Morphogenesis: An Outline of a General Theory of Models*. Benjamin/Cummings Publishing.

- Tinbergen, N. [1951]. *The Study of Instinct*. Clarendon Press.
- Turksen, B. [1986]."Interval valued fuzzy sets based on normal forms." *Fuzzy Sets and Systems*. Vol. 20, pp. 191-210.
- Turksen, B. [1994]."Interval valued fuzzy sets and fuzzy measures." *Proc. of the NAFIPS/IFIS/NASA '94*. IEEE Press, pp. 317-321.
- Turksen, I.B. [1996]."Non-specificity and interval-valued fuzzy sets." *Fuzzy Sets and Systems*. Vol. 80, pp. 87-100.
- Umerez, Jon [1995]."Semantic Closure: a guiding notion to ground Artificial Life." In: *Advances in Artificial Life*. F. Moran, A. Moreno, J.J. Merelo, and P. Chacon (eds.). Springer-Verlag, pp. 77-94.
- van Gelder, Tim [1991]."What is the 'D' in 'PDP': a survey of the concept of distribution." In: *Philosophy and Connectionist Theory*. W. Ramsey et al. Lawrence Erlbaum.
- Varela, F. [1979]. *Principles of Biological Autonomy*. Elsevier North-Holland.
- Varela, F. E. Thompson, and E. Rosch [1991]. *The Embodied Mind: Cognitive Science and Human Experience*. MIT Press.
- Varela, F.J. and P. Bourgine [1992]. *Towards a Practice of Autonomous Systems: Proceedings of the First European Conference on Artificial Life*. MIT Press.
- Vejnarová, J. and G.J. Klir [1993]."Measure of strife in Dempster-Shafer Theory." *International Journal of General Systems*. Vol. 22, pp. 25-42.
- von Glaserfeld, E. [1995]. *Radical Constructivism: A Way of Knowing and Learning*. The Falmer Press.
- von Foerster, H. and G.W. Zopf (eds.) [1962]. *Principles of Self-Organization*. Pergamon Press.
- von Foerster, Heinz [1960]."On self-organizing systems and their environments." In: *Self-Organizing Systems*. M.C. Yovits and S. Cameron (eds.). Pergamon Press, pp. 31-50. Reprinted on von Foerster [1981], pp. 2-22.
- von Foerster, Heinz [1965]."Memory without record." In: *Anatomy of Memory*. D.P. Kimble (ed.). Science and Behavior Books, pp. 388-433. Reprinted in von Foerster [1981], pp. 91-137.
- von Foerster, Heinz [1969]."What is memory that it may have hindsight and foresight as well?." In: *The Future of the Brain Sciences*. S. Bogoch (ed.). Plenum Press, pp. 1965 and 89-95.
- von Foerster, Heinz [1977]."Objects: tokens for (eigen-)behaviors." In: *Hommage a Jean Piaget: Epistemologie Genetique et Equilibration*. B. Inhelder, R. Gracia, and J. Voneche (Eds.). Delachaux et Niestel. Reprinted in von Foerster [1981], pp. 274-285.
- von Foerster, Heinz [1981]. *Observing Systems*. Intersystems Publications.
- von Neumann, J. [1966]. *The Theory of Self-Reproducing Automata*. University of Illinois Press.
- Waddington, C.H. [1972]."Postscript." In: *Towards a Theoretical Biology*. C.H. Waddington (ed). Edinburgh University Press.
- Wang, Z. and G. Klir [1992]. *Fuzzy Measure Theory*. Plenum Press.
- Way, Eileen C. [1991]. *Knowledge Representation and Metaphor*. Kluwer.
- Weaver, W. [1848]."Science and complexity." *American Scientist*. Vol. 36, pp. 536-544. Reprinted in Klir [1991], pp. 449-456.
- Wiener, N. [1961]. *Cybernetics*. MIT Press. Second Edition. (first edition 1948).
- Wilson, D.S. and E. Sober [1994]."Re-introducing group selection to the human behavioral sciences." *Behavior and Brain Sciences*. Vol. 17, pp. 585-654.
- Wilson, D.S. and A. Wells [1995]."Radical epistasis and the genotype-phenotype relationship." *Artificial Life*. Vol. 2, no.1, pp. 117-128.
- Wilson, S.W. [1988]."The genetic algorithm and simulated evolution." In: *Artificial Life*. C.G. Langton (ed.). SFI Studies in the Sciences of Complexity. Addison-Wesley, pp. 157-166.
- Wuketis, F.M. [1990]. *Evolutionary Epistemology and Its Implications for Humankind*. State University of New York Press.

- Yager, R.R. [1979]. "On the measure of fuzziness and negation. Part I: membership in the unit interval." *Int. J. of General Systems*. Vol. 5, pp. 221-229.
- Yager, R.R. [1980]. "On the measure of fuzziness and negation: Part II: lattices." *Information and Control*. Vol. 44, pp. 236-260.
- Yager, R.R. [1982]. "An introduction to applications of possibility theory." *Human Systems Management*. Vol. 3, pp. 246-269.
- Yager, R.R. [1983]. "Entropy and specificity in a mathematical theory of evidence." *Int. J. of General Systems*. Vol. 9, pp. 249-260.
- Yen, John [1990]. "Generalising the Dempster-Shafer theory to fuzzy sets." *IEEE Transactions on Systems, Man, and Cybernetics*. Vol. 20, pp. 559-570.
- Yuan, Bo, W. Wu, and Y. Pan [1994]. "On normal form based interval valued fuzzy sets and its application to approximate reasoning." *International Journal of General Systems*. .
- Zadeh, Lofti A. [1965]. "Fuzzy Sets." *Information and Control*. Vol. 8, pp. 338-353.
- Zadeh, Lofti A. [1971]. "Quantitative fuzzy semantics." *Informations Sciences*. Vol. 3, pp. 159-176.
- Zadeh, Lofti A. [1975]. "The concept of a linguistic variable and its application to approximate reasoning, I, II, and III." *Information Sciences*. Vol. 8, pp. 199-249;301-357, Vol. 9, pp. 43-80.
- Zadeh, Lofti A. [1978]. "PRUF-a meaning representation language for natural languages." *Int. J. of Man-Machine Studies*. Vol. 10, pp. 383-410.
- Zeleny, M., G. Klir, and K. Hufford [1989]. "Precipitation membranes, osmotic growths, and synthetic biology." In: *Artificial Life*. C. Langton (ed.). SFI Studies in the Sciences of Complexity. Addison-Wesley, pp. 125-155.
- Zhu, Q. and E.S. Lee [1995]. "Evidence theory in multivalued logic systems." *Int. J. of Intelligent Systems*. Vol. 10, pp. 185-199.
- Zimmerman, H. and P. Zysno [1980]. "Latent connectives in human decision making." *Fuzzy Sets and Systems*. Vol. 4, pp. 37-51.

INDEX

- AI, 2, 3, 5, 26, 29, 42, 43, 90, 129-131, 133, 140
AL, 2, 3, 5, 20, 26, 29, 33, 34, 41, 46-48, 62, 78, 80, 82, 88, 89, 95, 129, 131, 133, 138-142
Approximate Reasoning, iv, 6, 40, 41, 45, 48, 49, 54, 64, 65, 67, 69, 71, 95, 99, 100, 102, 110, 133, 137, 143
Artificial Intelligence, iv, 1, 2, 6, 8, 11, 15, 29, 46, 95, 135, 137-141
Artificial Life, iv, 2, 6, 8, 11, 15, 21, 23, 29, 76, 87, 88, 134, 136, 138-143
Autonomy, 11, 28, 142
Autopoiesis, 28
Belief, iv, 6, 7, 32, 41-43, 50-53, 62, 67, 69, 71-74, 133, 134, 136
Boolean Network, 11, 17, 30, 88, 89
CA, 112, 120-124
Cellular Automata, iv, 3, 7, 8, 9, 10, 13, 20, 75, 95, 112, 119, 137, 139
CGA, 83-87, 92, 95, 112, 113, 117-119, 121, 122, 124, 131-134
Chaos, 10, 15, 16, 138, 139
Chaotic, 9, 14-16, 34
Client-Server, 102, 106
Cognitive Categorization, iv, 6, 7, 17, 36, 37-40, 48, 49, 53, 127, 129, 134, 140
Computationalism, 1
Conflict, 46, 50, 51, 53, 54, 62, 63, 65, 66, 71, 72, 102, 104, 105, 138
Connectionism, 17, 129, 136
Connectionist, iv, vi, 2-5, 11, 17, 27, 33, 34, 36, 38, 49, 53, 97, 101, 128-130, 132, 136, 140, 142
Constructionism, 29
Constructivism, iv, 4, 6, 7, 9, 10, 12, 26-32, 36, 94, 101, 106, 126, 127, 129, 130, 137, 142
Context, i, iv, 2, 6, 7, 12, 19, 23, 25, 26, 30, 31, 35, 37, 39, 40, 43, 52-54, 67, 71-73, 76, 77, 79, 80, 86, 87, 99, 101, 105, 106, 110, 129-131, 133, 134, 139
Contextual Genetic Algorithm, 112
Critical Realism, 31, 32
Cybernetics, 10, 12, 15, 18, 137, 139, 140, 142, 143
Data Mining, iv, 8, 95, 110, 124
Database, iv, 40, 52, 54, 69, 96, 97, 100-102, 105, 106, 130, 134
Dawkins, 3, 23, 136
Dbase, 106
Dempster's rule, 43, 69
Dempster-Shafer, iv, 42, 46, 73, 137, 142, 143
Development, iv, 3, 7, 23-25, 27-30, 35, 36, 59, 76, 78-82, 87, 88, 90, 93, 106, 112, 121, 124, 128, 130-137, 141
direct encoding, 79, 118, 124
DNA, 19, 22, 23, 34, 76, 78, 80-82, 128, 129, 135, 140, 142
Dynamical System, 2, 10-12, 14, 16, 17, 75, 89-93, 132

Edge of chaos, 15, 16, 138, 139
EES, 126-134
Eigenbehavior, 10-12, 17, 18, 27, 141
Eigenvalue, 10, 11
Embodied Evolving Semiosis, 26, 126, 130
Embodiment, i, iv, 2, 4, 7, 18, 20, 27, 29, 32, 34, 36, 37, 77, 87, 88, 90, 124, 126, 131, 136
Emergence, 4-6, 11-18, 21, 22, 25, 120, 126, 132, 136
Emergent, 2, 4, 7, 9-12, 14-19, 21-23, 26, 27, 34, 49, 87, 88, 92, 93, 112, 120, 126, 127, 135, 136, 138, 141
Emergent Classification, 4, 10-12, 15-18, 26, 27, 34, 88, 92, 93, 126, 127, 141
Emergent Morphology, 10, 11, 23, 87, 88, 92, 112
Encoding, 6, 7, 75, 79, 81, 87, 88, 92-94, 95, 112-114, 117-119, 121-125, 131, 133
Epistasis, 124, 143
Evidence Set, 6, 36, 51, 52, 64-69, 73, 95, 99, 102-106, 109
Evidence Theory, 8, 41-43, 46, 53, 62, 67, 72, 73, 143
Evolutionary Constructivism, iv, 4, 6, 7, 9, 26, 28, 32, 36, 94, 101, 106, 126, 127, 129, 130
Evolutionary Realism, 31, 32
Evolving Semiosis, 5, 7, 26, 126, 130
FDP, 90-93, 112, 117, 118, 124, 131-134
Fuzziness, 44-47, 50, 64-66, 97, 98, 104, 140, 143
Fuzzy Convolution, 89, 90, 138
Fuzzy Development Program, 90
Fuzzy Logic, iv, 7, 8, 40, 47, 48, 50, 70, 78, 89-91, 100, 138
Fuzzy Set, 6, 44, 45, 47-50, 52, 64, 65, 70, 71, 73, 89-94, 97-100, 102-105, 112, 118, 119, 124, 131-134
GA, 79, 83-85, 87, 88, 92, 93, 95, 113-116, 118, 120-124
Genetic Algorithm, 3, 11, 78, 92, 94, 112, 143
Genetic Translation, 7
Genetics, 26, 106
Gould, 3, 23, 137
Indirect Encoding, 6, 7, 79, 88, 92-94, 95, 112-114, 117-119, 121-125, 131, 133
Information Sciences, 95, 143
Information Technology, iv, 2, 8
Interval Valued Fuzzy Set, 48
intuitionistic set, 50
IVFS, 45, 49-53, 64-68, 70, 71, 102, 103
Klir, iii, vi, 9, 37, 42, 46, 47, 57, 59, 133, 135, 137, 138, 140, 142, 143
Lakoff, 38, 40, 41, 48, 138
Machine Learning, 17, 95, 137
Metaphor, 33, 35, 106, 129, 141, 142
Natural Selection, iv, 3, 4, 6, 7, 11, 16-21, 23-25, 28, 31, 75-77, 79, 88, 106, 126, 128, 131
Neural Network, iv, 3, 11, 33, 34, 36, 49, 88, 95, 101, 112-114, 119, 125
Nonspecificity, 45-47, 50, 51, 54, 55, 57-63, 65, 66, 71, 104, 105, 133
Organizational Closure, 11, 77
Paradox, 18, 47, 106
Pask, vi, 18, 29, 128, 139
Pattee, iii, vi, 3, 14, 22, 25, 26, 34, 139, 140
Pragmatics, 1, 5, 26-28, 36, 75, 76, 93
Prototype, 39, 40, 48, 49, 52, 54, 97, 99, 129, 130, 137, 139, 142

Prototype Combination, 48, 49
Prototype Theory, 39, 139
Prototypicality, 39-41, 48, 52
Radical Constructivism, 27, 28, 31, 32, 36, 142
Realism, 30-32, 38, 135, 137
Representation, iv, 1, 2, 4-7, 10-15, 24, 25, 28, 29, 36, 38-40, 45-47, 49, 50, 52, 53, 65, 70, 71, 77, 95, 99, 121, 122, 126, 131, 132, 135, 137, 139, 141-143
Representationalism, 2-4, 6, 14, 36
RNA, iv, 7, 19, 25, 77, 79-84, 86, 87, 135, 138, 141, 142
RNA Editing, iv, 7, 25, 77, 79-84, 86, 87, 135, 138, 141, 142
Robotics, 30, 133
Rosch, 3, 11, 39, 40, 52, 128, 129, 141, 142
Salthe, vi, 3, 4, 12, 15, 21, 23, 128, 136, 139, 141
Second-order cybernetics, 12, 15
Selected Self-Organization, iv, 6, 7, 9, 15, 17, 18, 24, 26, 27, 30, 33, 75, 77, 87, 93, 94, 101, 124, 126, 129-131, 141
Self-organization, iv, 3, 5-7, 9, 10, 12, 15-18, 21-27, 29-31, 33, 35, 75, 77-79, 87, 93, 94, 101, 119, 124, 126, 127, 129-135, 138, 139, 141, 142
Semantic Closure, 21-26, 77, 97, 140, 142
Semantics, 1, 5, 17, 22, 25-27, 29, 33, 35, 36, 38, 46, 75, 76, 79, 110, 126, 127, 134, 136, 143
Semiosis, 4, 5, 7, 26, 106, 126, 127, 129-132
Semiotics, iv, 14, 25, 26, 75-80, 82, 83, 86, 87, 101, 110, 136, 141
Situated Robotics, 30, 133
SQL, 106
Subjective, iv, 1, 6, 7, 21, 33, 34, 37-39, 41, 51, 52, 72, 99, 110, 130, 134, 141
Subjectivity, 41, 53, 72, 97, 110
Symbols, 1-3, 14, 18, 20, 22, 23, 25, 26, 33-35, 75-77, 79, 80, 82-84, 128, 131, 134, 136, 140, 141
Syntax, 1, 5, 32, 33, 36, 76, 79, 80, 83, 110, 120, 126, 127, 129, 136
Systems Science, i, iii, iv, vi, 1, 138
Systems-Theoretic, iv, 14
TalkMine, 106-108, 110, 127, 129, 130, 132, 134
Theoretical Biology, 3, 26, 135, 142
Uncertainty, i, iv, 6, 7, 37, 38, 41, 44-50, 52-55, 57-59, 62, 63, 65-69, 71-73, 81, 95, 102, 104, 105, 110, 133, 134, 137, 138, 140, 141
Uncertainty-based information, 54, 59, 138
von Foerster, vi, 10, 12, 17, 27, 135, 142
von Neumann, 14, 18-21, 23, 30, 34, 126, 127, 142